SPREAD SPECTRUM COMMUNICATION SYSTEM EMPLOYING COMPOSITE SPREADING CODES WITH MATCHED FILTER DEMODULATOR

FIELD OF THE INVENTION

The present invention relates in general to communication systems and is particularly directed to a modulation, demodulation mechanism employing composite (multiple length) spreading codes that allows for the use of practical sized matched filters (e.g. surface acoustic wave devices) in the demodulator to despread the signal and keep power consumption low.

BACKGROUND OF THE INVENTION

High performance portable communication systems commonly employ some form of spreading sequence both as a security measure and to provide robustness against multipath fades. Although the despreading and data recovery mechanism in the receiver could be implemented using a high speed digital signal processing architecture, the required hardware would be impractical in terms of power required, size and weight. On the other hand, using strictly analog passive signal processing components, such as surface acoustic wave (SAW) devices, would require a complex matched filter design of prohibitive size, particularly where very long spreading sequences are used.

SUMMARY OF THE INVENTION

In accordance with the present invention, the excessive power requirements of purely digital processing systems and the impractical size (length) that would be required to implement a SAW transversal filter for an analog signal processor are significantly reduced by means of a hybrid despread and demodulation receiver for low symbol rate communications. At the transmitter a composite coding mechanism is used to spread the data signal. This composite, or compound, spreading mechanism is formed by multiplying different length coding sequences, thereby obtaining an overall signal processing operator the duration or symbol span of which is sufficient to maintain a high signal processing gain, but is considerably longer than can be processed using a practical sized passive (e.g. SAW) filter design. The design of the receiver takes advantage of the fact that the relatively short sequence can be despread using a practical SAW structure and is comprised of a hybrid signal processor, the front end of which contains a compact SAW matched filter and the downstream end of which is implemented using digital processing components. The matched filter removes the relatively short spreading sequence from the received signal and feeds its output to a mixer, which combines the output of the matched filter with the longer coding sequence to complete the despreading process. The despread signal is then differentially decoded and coupled to an integrate and dump circuit, which measures the energy in successive symbol intervals in order to determine the value of the respective data bits.

Preferably, the bit period of the data is a first integral multiple of the length of the short coding sequence, and the length of the relatively long coding sequence is a second integral multiple of the length of the short coding sequence, longer than the bit period. In addition, the first and second integers are relatively prime numbers.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 diagrammatically illustrates a composite encoding/spreading scheme in accordance with an embodiment of the present invention;

FIG. 2 shows the timing relationships among data and a pair of ("long" and "short") spreading sequences; and

FIG. 3 diagrammatically illustrates an embodiment of a demodulator for despreading and decoding a composite spreading code.

DETAILED DESCRIPTION

Before describing in detail the particular improved composite code spread spectrum communication system in accordance with the present invention, it should be observed that the present invention resides primarily in a novel structural combination of conventional communication circuits and components and not in the particular detailed configurations thereof. Accordingly, the structure, control and arrangement of these conventional circuits and components have been illustrated in the drawings by readily understandable block diagrams which show only those specific details that are pertinent to the present invention, so as not to obscure the disclosure with structural details which will be readily apparent to those skilled in the art having the benefit of the description herein. Thus, the block diagram illustrations of the Figures do not necessarily represent the mechanical structural arrangement of the exemplary system, but are primarily intended to illustrate the major structural components of the system in a convenient functional grouping, whereby the present invention may be more readily understood.

Referring now to FIG. 1, an encoding/spreading scheme for the composite code transmitter terminal in accordance with an embodiment of the present invention is diagrammatically illustrated as comprising a data input signal line **11**, over which digital data is coupled to a data encoder **13**. For purposes of the present description the encoding mechanism will be assumed to be an M-ary PSK encoder, such as a differential BPSK encoder. It should be understood however, that the encoding mechanism is not limited to M-ary encoding but may be any of a variety of other types of encoding techniques customarily used in digital communication systems. In the present example, BPSK encoder **13** operates on the input data stream to produce a prescribed multi-bit pattern the bit rate of which is a multiple of (e.g. eight times) the rate of the binary data on input link **11**. For a clock signal on link **15** at the representative eight times the bit rate of the data on input link **11**, BPSK encoder **13** generates the output sequence 11111111 (or 00000000, depending upon the previous output) when the input data bit on link **11** is a binary "1", and the alternating one-zero sequence (01010101) when the input data bit on link **11** is a binary "0".

The multibit (X8) encoded data stream produced by encoder **13** is coupled to one input **19** of a mixer **21**, to a second input **22** of which the output of a "long" spreading sequence generator **23** is applied. Like encoder **13**, "long" spreading sequence generator **23** is driven by the (X8) clock on link **15**, so that the pseudo random bits of its output code stream are of the same duration as the bits of the encoded differential BPSK bit stream. Mixer **21** multiplies the (BPSK) encoded data by pseudo random code of the "long" spreading sequence and supplies a first spread modulation output bit